

CLAIMS

What is claimed is:

- 5 1. A method of providing disordered breathing therapy to a patient, comprising:
detecting one or more conditions associated with disordered breathing;
predicting disordered breathing based on the one or more detected conditions;
and
delivering cardiac electrical stimulation therapy to mitigate the predicted
10 disordered breathing, wherein at least one of detecting, predicting, and delivering is
performed at least in part implantably.
2. The method of claim 1, wherein at least two of detecting, predicting, and
delivering are performed at least in part implantably.
- 15 3. The method of claim 1, wherein each of detecting, predicting, and delivering is
performed at least in part implantably.
4. The method of claim 1, wherein detecting the one or more conditions
20 comprises detecting a physiological condition.
5. The method of claim 1, wherein detecting the one or more conditions
comprises detecting a respiratory system condition.
- 25 6. The method of claim 1, wherein detecting the one or more conditions
comprises detecting a cardiovascular system condition.
7. The method of claim 1, wherein detecting the one or more conditions
comprises detecting a nervous system condition.

8. The method of claim 1, wherein detecting the one or more conditions comprises detecting a blood chemistry condition.
- 5 9. The method of claim 1, wherein detecting the one or more conditions comprises detecting a muscle system condition.
10. The method of claim 1, wherein detecting the one or more conditions comprises detecting a non-physiological condition.
11. The method of claim 1, wherein detecting the one or more conditions comprises detecting an environmental condition.
12. The method of claim 1, wherein detecting the one or more conditions
- 15 comprises detecting a contextual condition.
13. The method of claim 1, wherein detecting the one or more conditions comprises detecting a historical patient condition.
- 20 14. The method of claim 1, wherein detecting the one or more conditions comprises detecting a body-related condition.
15. The method of claim 1, wherein detecting the one or more conditions comprises detecting a condition used to verify the prediction of disordered breathing.
- 25 16. The method of claim 1, wherein detecting the one or more conditions comprises detecting a condition predisposing the patient to disordered breathing.

17. The method of claim 16, wherein detecting the predisposing condition comprises detecting a condition associated with an increased likelihood of disordered breathing.

5 18. The method of claim 1, wherein predicting the disordered breathing comprises predicting the disordered breathing will occur within a selected time interval from a time of the disordered breathing prediction.

10 19. The method of claim 18, wherein the selected time interval comprises about an 8 hour period following the time of the disordered breathing prediction.

20. The method of claim 18, wherein the selected time interval comprises a next sleep time following the time of the disordered breathing prediction.

15 21. The method of claim 18, wherein the selected time interval comprises about a 300 second period following the time of the disordered breathing prediction.

22. The method of claim 1, wherein detecting the one or more conditions comprises detecting a precursor condition to disordered breathing.

20 23. The method of claim 22, wherein detecting the precursor condition comprises detecting a condition associated with an impending onset of disordered breathing.

25 24. The method of claim 1, wherein predicting the disordered breathing comprises performing a real-time prediction of disordered breathing.

25. The method of claim 1, wherein predicting the disordered breathing comprises: comparing the one or more detected conditions to one or more sets of prediction criteria associated with disordered breathing; and predicting the disordered breathing based on the comparison.

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26. The method of claim 1, wherein predicting the disordered breathing comprises: comparing the one or more detected conditions to one or more sets of disordered breathing threshold criteria; and predicting the disordered breathing based on the comparison.

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27. The method of claim 1, wherein predicting the disordered breathing comprises: comparing a relationship between the one or more detected conditions to one or more sets of disordered breathing relationship criteria; and predicting disordered breathing based on the comparison.

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28. The method of claim 1, wherein predicting the disordered breathing comprises: computing an estimated probability that disordered breathing will occur based on the conditions; comparing the estimated probability to a threshold probability associated with an onset of disordered breathing; and predicting the disordered breathing based on the comparison.

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29. The method of claim 28, wherein computing an estimated probability comprises computing a composite estimated probability score.

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30. The method of claim 1, further comprising establishing one or more sets of disordered breathing prediction criteria.

31. The method of claim 30, wherein establishing the one or more sets of disordered breathing prediction criteria comprises establishing the one or more sets of disordered breathing prediction criteria based on the detected conditions.

5 32. The method of claim 30, wherein establishing the one or more sets of disordered breathing prediction criteria comprises establishing the one or more sets of disordered breathing prediction criteria based on clinical data.

33. The method of claim 1, further comprising:

10 providing the one or more sets of disordered breathing prediction criteria; and
adjusting a particular set of the disordered breathing prediction criteria using
the detected conditions.

34. The method of claim 33, wherein adjusting the one or more sets of prediction
15 criteria is performed at least in part implantably.

35. The method of claim 33, wherein adjusting the one or more sets of prediction
criteria comprises:

20 calculating an estimated accuracy for a particular set of prediction criteria; and
adjusting the particular set of prediction criteria based on the estimated
accuracy.

36. The method of claim 33, wherein adjusting the prediction criteria comprises:
calculated an estimated sensitivity for a particular set of prediction criteria; and
25 adjusting the particular set of prediction criteria based on the estimated
sensitivity.

37. The method of claim 33, wherein providing the one or more sets of prediction criteria comprises forming a particular set of prediction criteria based on data based on the one or more detected conditions.

5 38. The method of claim 33, wherein providing the one or more sets of prediction criteria comprises deleting a particular set of prediction criteria based on data based on the one or more detected conditions.

39. The method of claim 1, wherein delivering the cardiac electrical therapy to
10 mitigate the predicted disordered breathing comprises delivering the cardiac electrical therapy to reduce a severity of the predicted disordered breathing..

40. The method of claim 1, wherein delivering the cardiac electrical therapy to mitigate the predicted disordered breathing comprises delivering the cardiac electrical
15 therapy to prevent the predicted disordered breathing.

41. The method of claim 1, wherein delivering the electrical stimulation therapy comprises delivering cardiac pacing therapy.

20 42. The method of claim 1, wherein delivering the electrical stimulation therapy comprises delivering atrial pacing therapy.

43. The method of claim 1, wherein the delivering the therapy comprises delivering ventricular pacing therapy.

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44. The method of claim 1, wherein delivering the cardiac electrical therapy comprises delivering multi-chamber therapy.

45. The method of claim 1, wherein delivering the cardiac electrical therapy comprises delivering multi-site therapy.

46. The method of claim 1, wherein delivering the cardiac electrical therapy 5 comprises delivering non-excitatory therapy.

47. The method of claim 1, wherein delivering the therapy comprises delivering cardiac pacing therapy at a rate above an intrinsic rate.

10 48. The method of claim 1, wherein delivering the therapy comprises delivering cardiac pacing therapy at a rate above a normally programmed pacing rate.

49. A method of providing disordered breathing therapy to a patient, comprising: predicting disordered breathing;

15 adapting a therapy for the patient to mitigate the predicted disordered breathing; and

delivering the adapted therapy to the patient, wherein at least one of predicting, adapting, and delivering is performed at least in part implantably.

20 50. The method of claim 49, wherein at least two of predicting, adapting, and delivering are performed at least in part implantably.

51. The method of claim 49, wherein each of predicting, adapting, and delivering is performed at least in part implantably.

52. The method of claim 49, further comprising:
detecting one or more conditions associated with disordered breathing;
using a first group of the detected conditions for predicting disordered breathing; and
5 using a second group of the detected conditions for adapting the therapy to mitigate the predicted disordered breathing.

53. The method of claim 52, wherein detecting the one or more conditions comprises detecting a physiological condition.

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54. The method of claim 52, wherein detecting the one or more patient conditions comprises detecting a contextual condition.

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55. The method of claim 52, wherein the second group of the detected conditions comprises a condition used to assess an impact of the therapy on the patient.

56. The method of claim 52, wherein the second group of the detected conditions comprises a condition used to assess therapy efficacy.

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57. The method of claim 52, wherein the second group of the detected conditions comprises a condition associated with sleep quality.

58. The method of claim 52, wherein the second group of the detected conditions comprises a condition associated with patient comfort.

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59. The method of claim 52, wherein the second group of the detected conditions comprises a condition used to assess respiration quality.

60. The method of claim 52, wherein the second group of the detected conditions comprises a cardiovascular system condition.

61. The method of claim 52, wherein the second group of the detected conditions
5 comprises a respiratory system condition.

62. The method of claim 52, wherein the second group of the detected conditions comprises a nervous system condition.

10 63. The method of claim 52, wherein the second group of the detected conditions comprises a blood chemistry condition.

64. The method of claim 52, wherein detecting the conditions comprises detecting
a muscle system condition.

15 65. The method of claim 49, wherein adapting the therapy comprises adapting the therapy based on patient therapy interactions.

66. The method of claim 49, wherein adapting the therapy comprises adapting the
20 therapy to terminate the predicted disordered breathing.

67. The method of claim 49, wherein adapting the therapy comprises adapting the therapy to prevent the predicted disordered breathing.

25 68. The method of claim 49, wherein adapting the therapy comprises adapting the therapy based on detection of one or more episodes of disordered breathing.

69. The method of claim 49, wherein adapting the therapy comprises adapting the therapy based on a severity of one or more detected episodes of disordered breathing.

5 70. The method of claim 49, wherein adapting the therapy comprises adapting the therapy based on a duration of one or more detected episodes of disordered breathing.

10 71. The method of claim 49, wherein adapting the therapy comprises adapting the therapy based on a frequency of one or more detected episodes of disordered breathing.

72. The method of claim 49, wherein adapting the therapy comprises adapting a cardiac pacing therapy.

15 73. The method of claim 49, wherein adapting the therapy comprises adapting an atrial pacing therapy.

20 74. The method of claim 49, wherein adapting the therapy comprises adapting a ventricular pacing therapy.

75. The method of claim 49, wherein adapting the therapy comprises adapting a multi-chamber pacing therapy.

25 76. The method of claim 49, wherein adapting the therapy comprises adapting a cardiac pacing therapy at a rate above an intrinsic rate.

77. The method of claim 49, wherein adapting the therapy comprises adapting a cardiac pacing therapy at a rate above a normally programmed pacing rate.

78. The method of claim 49, wherein adapting the therapy comprises switching pacing sites.

5 79. The method of claim 49, wherein adapting the therapy comprises switching
pacing modes.

80. A medical device, comprising:

10 a detector system configured to detect one or more conditions associated with
disordered breathing of a patient;

a prediction engine coupled to the detector system and configured to predict
disordered breathing based on the detected conditions; and

15 a therapy delivery system coupled to the prediction engine and the detector
system and configured to deliver therapy to the patient to mitigate the predicted
disordered breathing, wherein the prediction engine includes an implantable
component.

81. The medical device of claim 80, wherein the therapy delivery system includes
an implantable component.

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82. The medical device of claim 80, wherein the therapy delivery system and the
detector system include implantable components.

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83. The medical device of claim 80, wherein the detector system comprises a
patient-internal sensor.

84. The medical device of claim 80, wherein the detector system comprises a
patient-external sensor.

85. The medical device of claim 80, wherein the detector system comprises a patient input device.

86. The medical device of claim 80, wherein the detector system comprises a
5 sensor configured to sense a physiological condition.

87. The medical device of claim 80, wherein the detector system comprises a sensor configured to sense a contextual condition.

10 88. The medical device of claim 80, wherein the detector system is configured to include at least one wirelessly connected component.

89. The medical device of claim 80, wherein the prediction engine is configured to compare the one or more detected conditions to one or more sets of disordered
15 breathing prediction criteria and predict the disordered breathing based on the comparison.

90. The medical device of claim 80, wherein the prediction engine is configured to establish a particular set of prediction criteria based on the detected conditions.

20 91. The medical device of claim 80, wherein the prediction engine is configured to adjust a particular set of prediction criteria based on the detected conditions.

92. The medical device of claim 80, wherein the prediction engine is configured to
25 perform real-time prediction of the disordered breathing.

93. The medical device of claim 80, further comprising a controller configured to adapt the therapy delivered to the patient.

94. The medical device of claim 93, wherein the controller is configured to adapt the therapy to reduce an impact of the therapy on the patient.

95. The medical device of claim 93, wherein the controller is configured to adapt
5 the therapy to enhance therapy efficacy.

96. The medical device of claim 93, wherein the controller is configured to adapt the therapy to reduce therapy interaction.

10 97. The medical device of claim 93, wherein the controller is configured to adapt the therapy to extend device service life.

98. The medical device of claim 80, wherein the therapy delivery system is configured to deliver cardiac pacing therapy.

15 99. The medical device of claim 80, wherein the therapy delivery system is configured to deliver non-excitatory electrical stimulation.

100. A disordered breathing therapy system, comprising:

20 means for detecting one or more conditions associated with disordered breathing in a patient;

means for predicting disordered breathing based on the one or more detected conditions; and

25 means for delivering cardiac electrical therapy to mitigate the predicted disordered breathing, wherein at least one of the means for detecting, the means for predicting, and the means for delivering includes an implantable component.

101. A disordered breathing therapy system, comprising:
 - means for predicting disordered breathing;
 - means for adapting a therapy for the patient to mitigate the predicted disordered breathing; and

5 means for delivering the adapted therapy to the patient, wherein at least one of the means for predicting, the means for adapting, and the means for delivering includes an implantable component.